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Conditions of Environmental Degradation in Brazilian Countryside Areas

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Abstract

This study aims to analyze the relationship between environmental degradation and economic growth in Brazil's countryside areas and describe the situation of countryside households in relation to environmental pollution. For this, we used the microdata from the National Sample Survey (PNAD, Brazil) for the year 2015 and the econometric analysis occurred through the ordered logit model. The results allowed us to conclude that the Northeast, followed by the North and the Midwest, are the regions in which households are most inadequate; on the other hand, the South-Southeast axis presents the households with the best sustainable conditions. By analyzing the relationship between environmental degradation and economic growth for the Brazilian countryside environment, it was concluded that economic growth presented the inverted "N" format in relation to degradation for all regions, in which income and dimensions of access to education, health and information were crucial to this achievement.

Keywords: environmental degradation, countryside area, Brazil

JEL: Q56, R11.

1. Introduction

The combination of environmental degradation and economic growth has generated discussions in the academic world, mainly due to concerns about the future of the planet. Over time, this relationship has been shown to be in a very conflicting context, since most authors state that the economic growth of nations has occurred without concern for the environment.

The causes of environmental degradation are many and have been widely discussed in the literature. Some studies relate them to poverty, while others point to economic growth as the main determinant (RODRIGUES et al., 2016). Considering Brazil as a developing country and possessing abundant natural resources, these relationships can serve as a basis for analyzing growth and development.

Some economic theories seek to explain the relationship between economic growth and environmental degradation generated by the environment. It can be highlighted in this debate the theory of the Environmental Kuznets Curve (EKC) which is based on the premise that when economic growth occurs in a developing country, pollution levels increase because, due to other basic priorities, the control of environmental degradation is not prioritized. However, as the country grows to a certain degree of growth, concern for the environment increases and, as a result, there is greater protection against environmental degradation, thus generating an inverted U-shaped curve.

Controversially, Oliveira et al. (2011) and Rodrigues et al. (2016) believe that EKC would only be valid with an intermediate or higher level of income. With a low income level, the relationship between environmental degradation and economic development would be inversely proportional. After an intermediate level, this relationship would be positive, but there would be a new tipping point that would make the trajectory decrease again, suggesting that environmental degradation would decrease again at high levels of economic growth.

The main types of pollution in countryside areas are caused by agricultural production and lack of basic sanitation. According to data from the National Household Sample Survey (IBGE, 2014), about 30 million Brazilians live in the countryside, with only 35.5% of households connected to water supply networks with or without internal plumbing. Only 5.45% are connected to the sewage collection system, which contributes directly and indirectly to the emergence of diseases and environmental degradation.

Thus, the present work aims to analyze the determinants and levels of environmental degradation in the countryside areas of the Brazilian regions in 2015 from existing aspects in households. In addition, stemming from the discussion of causal factors leading to the existence of a relationship between environmental degradation and economic growth, this study aims to verify whether environmental degradation has an inverted “N” relationship with income growth or whether this relationship goes in direction of the hypothesis of the Environmental Kuznets Curve (EKC).

The justification is that the analysis of these relations is relevant in the improvement of the economic theory, not only because it highlights the problem of environmental degradation, but also because it stimulates the investigation of ways that reduce the environmental impacts as the country tends to develop. From this perspective, the fact that Brazil is one of the world's largest creditors of “bio capacity” may enable a new path towards sustainability to be taken worldwide.

This article is structured in four sections in addition to this introduction. The second section consists of a literature review with part of the available production on the relationship between environmental degradation and economic growth. The third presents the methodology applied and the fourth section presents the results and discussion, followed by the conclusions.

2. Literature Review

2.1 Environmental Degradation and Economic Growth

The relationship between the level of environmental degradation and economic growth has been widely discussed in the academic world, but these studies are not new and date back to the late 1960s. The impact of growth on the environment was noted by Mishan (1969), Solow (1974) and Commoner (1972). A little later, Forster (1973) and Gruver (1976) analyzed the way economic growth takes place, considering the presence of undesirable environmental effects and the consequent introduction of pollution control in the neoclassical growth model (ARRAES; DINIZ; DINIZ, 2006).

In the literature, discussions about the extent to which this growth impacts the environment are not unanimous. According to Mueller (1996), empirical evidence points out that the environmental impact will depend, among other factors, on the stage of economic growth followed by the country's development. With the growth of the economy, the production of manufacturers has a greater participation in the domestic product and, as a consequence, a possible improvement of environmental indicators and income.

In controversy, Arraes, Diniz and Diniz (2006) state that higher income individuals consume more and thus create more pollution by generating solid waste per capita, as well as generating more air pollutants. As a result, as demand grows, firms produce more and, on average, also produce more pollutants and more industrial waste.

One of the main tools for analyzing the impacts of economic growth on the environment is the Environmental Kuznets Curve (EKC) model. This model emerged in the early 1990s through a study by Grossman and Krueger (1995) who, seeking to highlight the relationship between pollutant emissions and per capita GDP for the United States, described the evolutionary trajectory of pollution in this country over time as a result of its economic growth (BIAGE, 2012).

The EKC is characterized by the inverted "U" shape. The upward part of the curve reflects the natural progress of economic development, in which this process would be shifted from a clean agrarian economy to a polluted industrial economy. The downward part reflects the mechanism by which developed economies export pollution-intensive production processes to less developed economies, and the economy would only develop as a result of the growth of less resource and pollution intensive sectors (SURI; CHAPMAN, 1998).

According to Grossman and Krueger (1995), the evolution of an economy goes through a transition process: when economic growth occurs in an under developed country, pollution levels increase as a result of increase in production that generate pollutant emissions, however, from the moment the country reaches a certain degree of growth, society's awareness of the consequences of environmental degradation has matured.

As a result, the existence of a strictly linear relationship between environmental degradation and economic growth was questioned, and other empirical studies appeared to support the hypothesis of the Environmental Kuznets Curve. It is worth mentioning the studies by Selden and Song (1994) and Stern (2002), among others. In Brazil, the works of Lucena (2005), Cunha et al. (2008) and Serrano, Loureiro and Nogueira (2014) are also worth mentioning.

Selden and Song (1994), taking into account 30 countries, showed that there is substantial support to assure the “inverted U” hypothesis that at sufficiently high-income levels pollution could fall to zero. In turn, Stern (2002) conducted a survey, taking into account 64 countries between 1973 and 1990. According to the results found, there were changes in emissions due to changes in factors such as: scale of production, technological progress, energy use and industrial structure.

Estimating the EKC for Brazil for the period between 1970 and 2003, Lucena (2005) employed two different measures for the dependent variable of the estimated model, one being estimated with energy consumption and the other with carbon dioxide emissions. It was found that, in the case of carbon dioxide emissions, the estimates do not support the existence of an inverted U-shaped curve. Already the estimates of energy consumption were not conclusive, that is, it was not possible to confirm or refute the existence of an EKC for Brazil in the analyzed period.

Using ordinary least squares estimation, for a time series between 1980 and 2004, Cunha's work (2008) showed that an increase in per capita income increases the emission of carbon dioxide in the atmosphere. In the study proposed by Serrano, Loureiro and Nogueira (2014), the authors empirically verified the relationship between per capita product and CO2 emission in Brazil from 1980 to 2010 and obtained as results that per capita income and square per capita income have a positive and negative effect on CO2 emissions, respectively, while cubed per capita income has no effect on the proposed model.

However, the understanding of EKC behavior is complex given that the effects that income has on pollution levels can be decomposed into production scale effect, production composition effect and technological level effects used in the productive processes (BIAGE, 2012). Some authors such as Oliveira et al. (2011) and Rodrigues et al. (2016) believe that the EKC would only be valid after a certain level of income, and thus support the inverted “N” hypothesis.

The study by Oliveira et al. (2011), which aimed to study the relationship between income growth and deforestation under the EKC hypothesis in the municipalities of the Legal Amazon from 2001 to 2006, found that this relationship is verified as inverted “N”, i.e., deforestation is decreasing to low per capita GDP levels, then increasing as per capita GDP increases, and decreasing again with higher per capita GDP levels.

Going from this conception, in the work that aimed to verify the relationship between poverty and economic growth with environmental degradation in Brazil's countryside environment in 2015, Rodrigues et al. (2016) found an inverted “N” format relationship between income and degradation, meaning that for different income levels, its growth impacts differently impacts the environment, sometimes contributing to degradation (with an intermediate level), sometimes contributing to preservation (with low and high levels, respectively).

3. Methodology

The work methodology uses the ordered logit model to verify the relationship between environmental degradation and economic growth. This type of qualitative choice model aims to determine the probability of an individual, with a specific set of attributes, to make certain choices among some alternatives. The methodological procedure was divided into two parts: initially, the levels of environmental degradation in the Brazilian countryside area were analyzed through the basic sanitation infrastructure of the households of each region. Then, from the estimated probability models, the direction of the response of environmental degradation in relation to the changes in the determining variables that represent dimensions of economic growth and access to information, education and health were verified.

3.1 Data Source and Variable Description

The data source for the estimation of the models of probability of environmental degradation were the microdata of the National Household Sample Survey (PNAD) conducted by the Brazilian Institute of Geography and Statistics (IBGE) for 2015. In the model for environmental degradation in the Brazilian countryside area, the sample totals 50,593 households, and for analysis of each of the Brazilian regions separately the data comprises 21,643 samples from the Northeast, 11,721 from the North, 7,344 from the Southeast, 6,326 from the South and 3,559 from the Midwest.

As PNAD is a complex sample survey, it is necessary to use a sample expansion factor so that estimates are not biased. In this case, to attribute the household weight provided in the database itself. The large number of samples from the Northeast is due to the region having the highest percentage of inhabitants living in countryside areas, with 26,88% of the population (IBGE, 2014).

For the analysis of the models, 14 variables were included[1] which are distributed in five dimensions as shown in Table 1:

[1] With the exception of per capita income (as well as its quadratic and cubic term) and years of schooling, the remaining variables are dummies.

Table 1. Description of the variables used and their equivalent dimensions

Dimensions	Derived Variables	Description
Environmental degradation	Destination given to household waste	Binary variable that takes the value 0 for adequate and 1 for inappropriate.
	Sanitary sewage type	Binary variable that takes the value 0 for adequate and 1 for inappropriate.
	Type of fuel used in the stove	Binary variable that takes the value 0 for adequate and 1 for inappropriate.
	House lighting form	Binary variable that takes the value 0 for adequate and 1 for inappropriate.
Income	Monthly per capita household income	Variable that includes the family monthly income range per person.
	Monthly squared per capita household income	Variable that includes the family monthly income range per person squared.
	Monthly cubed per capita household income	Variable that includes the family monthly income range per person cubed.
Information	Access to radio	Binary variable that assumes the value of 0 for households that have access to the device and 1 for those without.
	Access to television	Binary variable that assumes the value of 0 for households that have access to the device and 1 for those without.
	Access to internet	Binary variable that assumes the value of 0 for households that have access to the device and 1 for those without.
Education	Years of study	Variable that includes the interviewee's years of study.
	School attendance	Binary variable that takes the value of 0 for those attending or attending schools and 1 for those not attending or not attending
Health	Access to piped water	Binary variable that assumes the value of 0 for the household where the source of water is through the general network and 1 for those coming from other factors.
	Access to filtered water	Binary variable that assumes the value of 0 for households with access to filtered water and 1 for those without.

Source: Prepared by the authors based on PNAD data.

For the construction of the model-dependent variable, four variables that represent the dimension of environmental degradation were analyzed together: destination given to household waste, type of sewage disposal, type of fuel used in the stove and the form of household lighting. The weight was distributed as follows:

yi = 0, if destination given to household waste, the type of sewage disposal, the type of fuel used in the stove and the form of household lighting are "adequate";

yi = 1, if at least one of the four variables is “inadequate";

yi = 2, if two of the four variables are "inadequate ".

yi = 3, if three or all variables are "inadequate ".

Where “adequate” should be understood as the option that least negatively impacts the environment, exerting a socially acceptable level of degradation.

The destination of household waste is considered “adequate” when it is collected directly or indirectly, and “inadequate” when it is burned or buried on property, thrown on vacant or public place, thrown into the river, lake or sea, or other destination.

With regard to sanitary sewage, it is considered “adequate” when the septic tank is connected to the sewage or rainwater collection system, or to the general sewer or rainwater network at home, and “inadequate” when the septic tank is not turned on to the sewage or rainwater collection system, or exhaustion is discharged into rudimentary sump, ditch, river, lake or sea, or elsewhere.

For the type of fuel used in the stove, it is considered "adequate" when it is via canister or piped gas or electric power, and "inappropriate" when the fuel is wood or coal. Finally, the form of household lighting is “adequate” when it is by electricity (grid, generator, or solar), and “inadequate” when lighting is by oil or kerosene.

The sum of the dependent variable represents intensity levels for environmental degradation, where:

yi = 0: "Absence" of degradation;

yi = 1: Weak degradation;

yi = 2: Medium degradation;

yi = 3: Strong degradation.

In order to identify the relationship between economic growth and environmental degradation, the individual's monthly per capita household income along with their quadratic and cubic terms were analyzed. The information dimension represents the degree of access to communication devices, such as radio, television and internet, where the latter was analyzed if the respondent would have used the internet through home network, mobile phone, tablet, or other.

To represent the education dimension, the variables years of study of the reference person and the school attendance of the interviewees were used. Finally, to represent the minimum health conditions, a variable was constructed for water quality, where the household would have access to filtered water, and if the household had access to good quality water, which would be adequate when coming from general network with internal channeling, and inadequate, when coming from wells, springs or others.

3.2 Econometric Model

The ordered logit model is a multinomial model, and its dependent variable assumes values that establish a certain ordering of the data, not linearly, but in order to rank the possible results. The difference between linear regression and ranking is that, although apparently subtle, it is of great importance for the choice of the estimation method used in this study, where an ordinary regression, in this case, would fatally fail to consider the ordinal nature of the dependent variable.

The dependent variable related to environmental degradation was constructed non-metrically and the choices were ordered according to intensity levels, in which the observed response was modeled considering a latent variable y_i^* which depends linearly on the explanatory variables x_i'. In our case, y_i^* assigns numbers to individual responses as follows: 0 for "no degradation", 1 for "poor degradation", 2 for "medium degradation" and 3 for "strong degradation". Thus, the template can be specified as follows:

$$y_i^* = x_i'\beta + u_i \quad \text{(Equation 1)}$$

In which: $y_i^*$is an unobserved measure of degradation; $x_i'$is a feature vector of the household and its residents; β, the coefficient vector; and u_i is the random error term.

Before analyzing the results of the coefficients it was essential to observe the statistical significance of the "CUT" threshold parameters, as they inform the need for ordering of the dependent variable. If the threshold parameters are statistically different, the ordered model is adequate. According to Cameron and Trivedi (2009), for an ordered model with n alternatives, one can define:

$$y_i = j \text{ if } \alpha_{j-1} < y_i^* \leq \alpha_j, \quad \text{(Equation 2)}$$

$$j = 1,2,3, \ldots, m$$

In which: α_{j-1} e α_j are threshold or cutoff parameters known as "CUT". For j = 1 we have $\alpha_0 = -\infty$; and when j = m, $\alpha_m = \infty$. The other "CUT" parameters are determined together with β by the Maximum Likelihood estimator, which maximizes the probability of occurrence of the specific sample.

Rewriting (1) in regards of probability:

$$\Pr(y_i = j) = \Pr\left(\alpha_{j-1} < y_i^* \leq \alpha_j\right) \quad \text{(Equation 3)}$$

Substituting (1) in (3):

$$\Pr(y_i = j) = \Pr\left(\alpha_{j-1} < x_i'\beta + u_i \leq \alpha_j\right) \quad \text{(Equation 4)}$$

$$\Pr(y_i = j) = \Pr\left(\alpha_{j-1} < x_i'\beta + u_i \leq \alpha_j - x_i'\beta\right)$$

Assuming that u_i follows a logistic distribution with cumulative probability density function,

$F(z) = e^z/(1 + e^z)$ you have:

$$\Pr(y_i = j) = F(\alpha_j - x_i'\beta) - F(\alpha_{j-1} - x_i'\beta) \qquad \text{(Equation 5)}$$

$$\Pr(y_i = j) = \frac{e^{\alpha_j - x_i'\beta}}{1+e^{\alpha_j - x_i'\beta}} - \frac{e^{\alpha_{j-1} - x_i'\beta}}{1+e^{\alpha_{j-1} - x_i'\beta}}$$

Substituting (5) in the Likelihood Function log gives (6). Its maximization generates the Maximum Likelihood estimators.

$$\ln L = \sum_{j=0}^{m} \sum_{y=i} \ln\left[F(\alpha_j - x_i'\beta) - F(\alpha_{j-1} - x_i'\beta)\right] \qquad \text{(Equation 6)}$$

The coefficient signals can positively associate the growth direction of the variable of interest with the probability of the last category and negatively this same sense for the first category, that is, positive coefficients indicate growth in the probability of the last category and decrease in the probability of the first category (GREENE; HENSHER, 2010).

To test whether the relationship between environmental degradation and economic growth in the Brazilian countryside meets the EKC hypothesis or the inverted "N" hypothesis, three econometric models were initially constructed, in which it was found that the dependent variable is related to per capita income and its quadratic and cubic terms, respectively, omitting the other independent variables.

Then, the probabilistic model was built with all the study variables. However, as the coefficients of the Ordered Logit model are not interpreted directly, it is necessary to estimate the marginal effect as follows:

$$\frac{\partial \Pr(y_i = j)}{\partial x_i} = [F'(\alpha_j - x_i'\beta) - F'(\alpha_{j-1} - x_i'\beta)]\beta \qquad \text{(Equation 7)}$$

The influence of independent variables on the rate of environmental degradation can be estimated by the marginal effect, which is the effect that changing one unit of the independent variables has on the estimated probability for the predicted severity categories in the model. Greene and Hensher (2010) showed that, unlike traditional linear regression, neither the sign nor the magnitude of the coefficients are informative about the partial (or marginal) effects of the explanatory variables of the ordered models, since the coefficients are directly related to the values of the latent variable y* and not with the values of the observed categorical variable (y).

Thus, it is possible to show that the effect of changing a variable in the model depends on all other parameters, the observed data and the category of interest. According to Long and Freese

(2006), in logistic model regressions, marginal effects measure discrete modifications in a more informative manner, further allowing a more accurate explanation of the effects of each explanatory variable on the scale of environmental degradation levels.

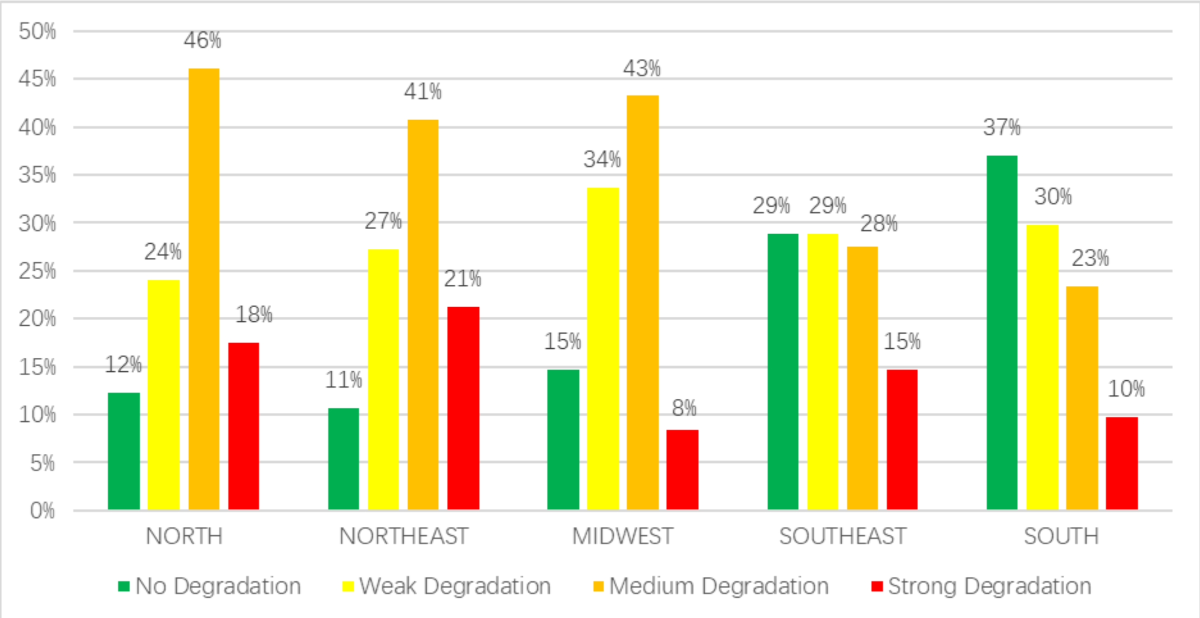
The analysis of the marginal effects was made first for the Brazilian countryside environment and then for the countryside environments of each of the regions separately.

4. Results and Discussion

This section was divided into two parts: first, for a better analysis of the study, we verified the levels of environmental degradation in the countryside areas of the Brazilian regions through aspects existing in the households; then, the results of the probability analyzes of the degradation conditioners in the Brazilian countryside area will be presented through estimates of the ordered logit model.

4.1 Analysis of the Level of Environmental Degradation in Countryside Areas of Brazilian Regions

The results of the survey indicate that in 2015, 82.73% of the destination given to domestic waste, the type of sewage, the fuel used in the stove and the way of lighting of countryside households in Brazil are inadequate, i.e., have some negative impact on the environment, and only 17.27% are free from degradation. Of that percentage, about 27.54% of the territory has a mild level of devastation, 38.11% comprises medium degradation, and 17.07% already suffers from a high rate of environmental degradation. For a better explanation, the intensity of environmental degradation in countryside areas was divided for the five Brazilian regions, as illustrated in Graph 1.



Graph 1. Level of environmental degradation in countryside areas of Brazilian regions

Source: Prepared by the authors from the estimated results.

The Northeast is the most degraded region of Brazil, where 89% of households have some kind of inadequacy regarding the preservation of the environment, as shown in Graph 1. In addition, it is in this Region that the highest percentage of strong degradation is found, in which about 21% of households are totally degrading, and the one that represents the lowest percentage of non-degrading households (11%).

Not far from this scenario, the North is the second most degraded region in Brazil, with 88% of inadequate households, and it has the highest percentage of mean degradation intensity (46%) and the second highest percentage of strong degradation (18%). Then comes the Midwest region, with 85 percent of inadequate countryside households. These figures show that the three regions mentioned still have a deficit in providing basic sanitation services, and that this has a major negative impact on the environment.

On the other hand, although 63% of the territory still presents some kind of degradation, the countryside area of the Southern Region presents garbage collection, sanitary sewage, fuel used in the stove and the most adequate form of lighting, covering about 37%. Immediately thereafter comes the Southeast Region, where 29% of households have no degradation levels. This result was already expected, as the South-Southeast axis possesses a greater economic dynamic, which presupposes the existence of more services and better quality.

4.2 Probabilistic Analysis of Degradation Conditioners in Brazilian Countryside Areas

Starting from the probabilistic model, as can be seen in the results of Table 2, the coefficients of all variables are statistically significant[2].

2 In addition to being significant, as the threshold parameters "CUT 1", "CUT 2" and "CUT 3" are adequate, ie statistically different, the ordered logit model is apt to be studied.

Table 2. Estimation of Ordered Logit Models

VARIABLE	MODEL 1	MODEL 2	MODEL 3	MODEL 4
Per capita income	-0,00069*** (0,00016)	-0,00091*** (0,00001)	-0,00123*** (0,00002)	-0,00070*** (0,00002)
Per capita income ^2	---	$4,63e^{-8}$*** ($2,39e^{-9}$)	$1,46e^{-7}$*** ($5,74e^{-9}$)	$8,51e^{-8}$*** ($5,26e^{-9}$)
Per capita income ^3	---	---	$-3,53e^{-12}$*** ($1,81e^{-13}$)	$-2,04e^{-12}$*** ($1,66e^{-13}$)
Information through the radio	---	---	---	-0,09837*** (0,01807)
Information through the television	---	---	---	1,06755*** (0,03508)
Information through the internet	---	---	---	0,84942*** (0,02073)
Years of studying	---	---	---	-0,03689*** (0,00231)
School attendance	---	---	---	-0,09781*** (0,02681)
Access to piped water	---	---	---	1,21138*** (0,02073)
Access to filtered water	---	---	---	-0,13712*** (0,01707)
CUT 1	-1,99367*** (0,01556)	-2,09340*** (0,01628)	-2,22205*** (0,01734)	-1,44336*** (0,03087)
CUT 2	-0,58652*** (0,01249)	-0,67695*** (0,01318)	-0,79644*** (0,01426)	0,12387*** (0,03009)
CUT 3	1,24871*** (0,01395)	1,16934*** (0,01439)	1,06341*** (0,01511)	2,24142*** (0,03198)

Source: Prepared by the authors based on PNAD data.

Note 1: *** Significant at 1%.

Note 2: The values in parentheses represent the standard deviation.

As shown in Table 2, the variables family income (as well as its cubic term), level of information by radio, years of schooling, school attendance and access to filtered water presented negative signs in relation to the levels of environmental degradation. On the other hand, the coefficients of the variables squared household income, information access by both television and internet, and access to piped water are positive.

Analyzing the probability of income (a variable that represents economic growth) in the impact on environmental degradation in Brazil's countryside reaffirmed that income has an inverted "N" relationship with degradation, in line with studies by Oliveira et al. (2011) and Rodrigues et al., (2016).

The income coefficients showed negative, positive and negative signs, respectively, so for very low income levels, income growth decreases the likelihood of environmental degradation; soon after, from an intermediate income level, income growth and degradation start to reflect the behavior established by the Environmental Kuznets Curve, where income growth increases the likelihood of degradation. However, after a higher income level, there would be a new turning point that would make the trajectory decrease again.

However, these estimated parameter values do not give us accurate information about the effects or elasticities, as the estimated coefficients do not reflect the marginal effects of the variables. To this end, the other variables were fixed at their observed values and imputed several values to the regressor vector, shown in Table 3.

Quantitatively, when there is an increase in a low income level, the likelihood of strongly degrading the environment decreases by 0.0001, as long as this population had an intermediate income level, an increase in income would also increase the likelihood of strong degradation (1.05e-08). When there was a significant increase in income, the likelihood that the population would severely degrade would be negative again (-2.50e-13).

The explanation is that low-income countryside populations, even though they do not have access to many resources, are concerned with preserving the few remaining resources of their environment. From an intermediate level of income, there is no such concern, and the population starts to invest in resources that they previously did not have, which implies an increased consumption and production of waste and pollutants, which would consequently increase the degradation. However, with a high income level, the countryside environment gains in development where, although there is still a level of degradation, there will be a greater awareness of the population with environmental preservation, as well as having the resources to implement sustainable mechanisms and policies.

The access to television and the Internet was directly related to degradation, while access to radio was inversely related, that is, the more the countryside population has access to information through radio, the lower will be the likelihood of degrading the environment. This fact can be evidenced when one observes the marginal effects, in which for access to TV and the Internet they start negative and become positive as the degradation becomes strong, while for the access to radio we have the opposite effect. The explanation for this is based on the premise that the radio transmits information closer to the interlocutor, as well as being an easily accessible and widely used communication vehicle in countryside areas.

Table 3. Determinants of likelihood of environmental degradation in Brazilian Countryside Areas

VARIABLE	MODEL	MARGINAL EFFECTS			
		No Degradation	Weak Degradation	Medium Degradation	Strong Degradation
Per capita income	-0,0007*** (-28,00)	9,05e-05 (28,16)	5,59e-05 (27,12)	-6,02e-05 (-28,01)	-8,63e-05 (-27,55)
Per capita income ^2	8,51e-8 *** (16,20)	-1,10e-08 (-16,20)	-6,78e-09 (-16,12)	7,29e-09 (16,21)	1,05e-08 (16,13)
Per capita income ^3	-2,04e-12 *** (-12,29)	2,63e-13 (12,28)	1,62e-13 (12,27)	-1,75e-13 (-12,30)	-2,50e-13 (-12,26)
Information through the radio	-0,0983*** (-5,44)	0,0126 (5,44)	0,0078 (5,43)	-0,0084 (-5,44)	-0,0120 (-5,44)
Information through the television	1,0675*** (30,43)	-0,1375 (-29,72)	-0,0849 (-29,71)	0,0913 (27,92)	0,1310 (31,18)
Information through the internet	0,8494*** (41,01)	-0,1094 (-41,37)	-0,0675 (-39,18)	0,0727 (42,36)	0,1043 (39,28)
Years of study	-0,0368*** (-15,92)	0,0047 (15,92)	0,0029 (15,78)	-0,0031 (-15,88)	-0,0045 (-15,85)
School attendance	-0,0978*** (-3,65)	0,0126 (3,65)	0,0077 (3,65)	-0,0083 (-3,65)	-0,0120 (-3,65)
Access to piper water	1,2113*** (58,43)	-0,1556 (-53,71)	-0,0963 (-59,32)	0,1037 (50,97)	0,1487 (59,65)
Access to filtered water	-0,1371*** (-8,03)	0,0176 (8,03)	0,0109 (8,02)	-0,0117 (-8,04)	-0,0168 (-8,02)
Log likelihood		-61220,863			
Pseudo R^2		0,0887			
Number of observations		50.593			

Source: Prepared by the authors from the estimated results.

Note 1: *** Significant at 1%.

Note 2: Z statistics in parentheses for N = 50,593.

As also illustrated in Table 3, for the education dimension, also visualizing the results of the marginal effects, it was noted that both variables had an inverse relationship with the degradation. Quantitatively, the more years of study the individual has and the greater the school attendance of the population, the lower the likelihood of strong degradation of the environment, as for this the reduction will be 1.2% and 0.45%, respectively. These results were already expected, because the presence in schools makes people build social values, knowledge, skills, attitudes and competences aimed at the conservation of the environment that are essential for the quality of life and the sustainability of their environment.

In the health dimension, the more the population has access to filtered water, the less likely it is to strongly degrade the environment (1.68%), whereas the access to domestic water supply from internal canalization was directly related to degradation, and the probability of strong degradation was 14.87%. This fact was contrary to what the literature suggests, and it would be more appropriate that the population with an adequate supply network would degrade less, but the result is that water may not be used correctly in countryside areas, as for example being wasted, and when the population has their water supply coming from other factors, the concern with pollution would have to be greater.

Following the analysis of the relationship between environmental degradation and economic growth for each region in Brazil's countryside, as shown in Table 4, it is clear that income also has an inverted "N" relationship with degradation for the five regions. However, unlike the Southeast, which presented the same results as the model in reference to Brazil (Table 3), the other regions presented some changes[3].

The northern and northeastern regions of Brazil were the ones with the highest number of households with some kind of inadequacy regarding the preservation of the environment in their countryside environment. For both regions it can be seen that the variable school attendance was not statistically significant to explain the levels of countryside degradation. On the other hand, the variable years of schooling was statistically significant with a negative relationship with degradation, that is, the more years of schooling the countryside population had, the lower the probability of not strongly degrading, with a percentage of 0.52% for the North region, and 0.19% for the Northeast. This fact shows that, despite the insignificance of school attendance, the more time an individual spends in school, the more one tends to preserve the environment.

[3] The detailed determinants of environmental degradation levels on the countryside areas of brazilian regions are in the Apendix.

Table 4. Marginal effects of environmental degradation in countryside areas of Brazilian regions

VARIABLE	Level of degradation	MARGINAL EFFECTS				
		NORTH	NORTHEAST	Midwest	SOUTH	SOUTHEAST
Per capita income	Null	$5{,}77e^{-05}$	$1{,}07e^{-04}$	$6{,}79e^{-05}$	$1{,}64e^{-04}$	$1{,}28e^{-04}$
	Weak	$5{,}26e^{-05}$	$1{,}36e^{-04}$	$6{,}39e^{-05}$	$-6{,}77^{-6}$	$2{,}62e^{-05}$
	Average	$-4{,}16e^{-05}$	$-6{,}73e^{-05}$	$-8{,}79e^{-05}$	$-9{,}24e^{-05}$	$-7{,}01e^{-05}$
	Strong	$-6{,}86e^{-05}$	$-1{,}76e^{-04}$	$-4{,}47e^{-05}$	$-6{,}47e^{-05}$	$-8{,}47e^{-05}$
Per capita income ^2	Null	$-6{,}51e^{-09}$	$-2{,}97e^{-8}$	$-3{,}13e^{-8}$	$-5{,}34e^{-8}$	$-1{,}47e^{-8}$
	Weak	$-5{,}94e^{-09}$	$-3{,}79e^{-8}$	$-2{,}94e^{-8}$	$2{,}21e^{-9}$	$-2{,}99e^{-9}$
	Average	$4{,}70e^{-09}$	$1{,}87e^{-8}$	$4{,}06e^{8}$	$3{,}01e^{-8}$	$7{,}99e^{-9}$
	Strong	$7{,}75e^{-09}$	$4{,}89e^{-8}$	$2{,}01e^{-8}$	$2{,}11e^{-8}$	$9{,}65e^{-9}$
Per capita income ^3	Null	$1{,}46e^{-13}$	$1{,}96e^{-12}$	$3{,}80e^{-12}$	$4{,}52e^{-12}$	$3{,}45e^{-13}$
	Weak	$1{,}34e^{-13}$	$2{,}50e^{-12}$	$3{,}56e^{-12}$	$-1{,}87e^{-13}$	$7{,}04e^{-14}$
	Average	$-1{,}06e^{-13}$	$-1{,}23e^{-12}$	$-4{,}91e^{-12}$	$-2{,}55e^{-12}$	$-1{,}88e^{-13}$
	Strong	$-1{,}74e^{-13}$	$-3{,}23e^{-12}$	$-2{,}44e^{-12}$	$-1{,}79e^{-12}$	$-2{,}27e^{-13}$
Information through the radio	Null	0,0188	-0,0019	-0,0112	0,1495	0,0776
	Weak	0,0171	-0,0024	-0,0105	-0,0061	0,0158
	Average	-0,0135	0,0012	0,0145	-0,0843	-0,0423
	Strong	-0,0224	0,0031	0,0072	-0,0590	-0,0511
Information through the television	Null	-0,1377	-0,0903	-0,0892	-0,1631	-0,1509
	Weak	-0,1257	-0,1151	-0,0836	0,0067	-0,0308
	Average	0,0994	0,0568	0,1154	0,0920	0,0823
	Strong	0,1639	0,1486	0,0573	0,0643	0,0994
Information through the internet	Null	-0,1008	-0,0561	-0,1113	-0,1324	-0,1980
	Weak	-0,0919	-0,0716	-0,1043	0,0054	-0,0404
	Average	0,0728	0,0353	0,1440	0,0746	0,1080
	Strong	0,1200	0,0924	0,0715	0,0522	0,1304
Years of study	Null	0,0044	0,0030	0,0047	0,0046	0,0093
	Weak	0,0040	0,0038	0,0044	-0,0001	0,0019
	Average	-0,0031	-0,0019	-0,0063	-0,0021	-0,0051
	Strong	-0,0052	-0,0049	-0,0030	-0,0018	-0,0061
School attendance	Null	0,0021	0,0054	0,0274	-0,0044	0,0689
	Weak	0,0019	0,0069	0,0257	0,0001	0,0140
	Average	-0,0015	-0,0034	-0,0355	0,0025	-0,0375
	Strong	-0,0025	-0,0009	-0,0176	0,0017	-0,0453
Access to piped water	Null	-0,1556	-0,1095	-0,0971	0,1904	-0,0935
	Weak	-0,0963	-0,1396	-0,0909	0,0078	-0,0191
	Average	0,1037	0,0689	0,1256	0,1074	0,0510
	Strong	0,1487	0,1802	0,0624	0,0751	0,0616
Access to filtered water	Null	0,0265	-0,0035	-0,0364	-0,0602	0,0663
	Weak	0,0241	-0,0045	-0,0341	0,0024	0,0135
	Average	-0,0191	-0,0022	0,0471	0,0340	-0,0361
	Strong	-0,0315	-0,0058	0,0234	0,0237	-0,0437
Log Likelihood		-12861,899	-25759,841	-4128,0349	-7935,2567	-9316,8682
Pseudo R^2		0,1310	0,0758	0,0476	0,0315	0,0632
Number of observations		11.721	21.643	3.559	6.326	7.344

Source: Prepared by the authors from the estimated results.

Also in the information dimension, the variable that encompasses radio access was not significant to analyze the likelihood of degradation of countryside areas in the Northeast. In turn, for the north countryside, when the information is accessed through the radio, the percentage of not degrading strongly is 2.24%, which shows once again that the radio shows itself as a vehicle that presents relevant nature preservation information.

The variables that analyze the health dimension did not present the expected results for the North-Northeast axis. Initially, access to filtered water was not statistically significant to explain degradation levels for the Northeast, but for the North there was an adequacy of what is expected as the more the population has access to filtered water, the lower will be the probability of strongly degrading the environment, with a percentage of 3.15%. On the other hand, for the variable that analyzes the access to domestic water supply from internal plumbing, it was directly related to degradation for the North, with a percentage of 14.87% for the North and 18.02% for the Northeast. In addition to factors previously mentioned, this result is explained by the fact that households in both regions have inadequate plumbing networks and consequently generate waste of water.

It is noteworthy that, for the Northeast, the variables radio access, school attendance and access to filtered water were not significant for analysis. This fact draws attention, given the fact that, compared to the model that analyzes the Brazilian countryside environment in general, all these variables mentioned are inversely related to degradation. Therefore, this is another observation that explains the position of the Northeast as the region that has the most inadequate households in relation to non-degradation.

For the Midwest region, the variables access to information via radio was the only statically insignificant variable to explain countryside degradation levels, while the other information dimension variables were significant and showed positive signs regarding degradation on the environmental degradation level, as well as the health dimension variables. On the other hand, the variables years of schooling and school attendance (education dimension) showed negative signs regarding the degradation when it comes to environmental degradation.

The more the countryside population in the Midwest has access to information through television, the probability of strongly degrading the environment will be 5.73%. In addition, internet access would also increase this level of degradation by 7.15. %. These results lead us to emphasize that the population does not use these communication vehicles to have a more precise knowledge about the preservation of the environment, or the vehicles themselves are not concerned with emphasizing such a relevant topic as degradation.

In the health dimension, the likelihood of strong degradation for households with access to filtered water will be 2.34%, and for the variable that analyzes access to water supply from indoor sewage, this percentage will be 6.24%. For the education dimension, both variables had an inverse relationship with the degradation, and the more years of study the countryside population have, the probability of not strongly degrading the environment will be 0.3%, and for the variable school attendance this percentage will be 1.76%, showing that a good school attendance causes the population to worry more about the quality of their environment.

The South-Southeast axis had the lowest number of households with some type of inadequacy regarding the preservation of the environment in their countryside environments. The Southeast region presented the same results of the model referring to the national analysis, and all coefficients were statistically significant. For this, the variables access to television and the Internet, as well as access to household water supply from internal plumbing, were directly related to the degradation, while access to the radio, access to filtered water and the education dimension variables obtained an inverse relationship in relation to degradation. For the southern region, the difference is that the variable school attendance was not significant, and both health dimension variables had a positive relationship with the degradation.

In the education dimension, the more years of study the individual has in the Southern region, the probability of not strongly degrading the environment will be 0.18%, and in the Southeast 0.61%. Regarding the variable school attendance, for the Southeast, greater participation of the population in schools would increase the probability of not degrading strongly by 4.53%.

In the access to information dimension, the more the countryside population of the Southern region has access to information through television, the probability of strongly degrading the environment will be 9.2%, while in the Southeast this percentage will be 9.94%. Similarly, internet access would also increase the likelihood of this level of degradation by 5.22% in the South region, and by 13.04% in the Southeast.

Finally, in the health dimension, the more the population of the Southeast has access to filtered water, the less likely it is to strongly degrade the environment (4.47%), while in the South this percentage is the opposite, where the more the population have access to filtered water, the probability of degradation will be 2.37%. For the variable access to household water supply from internal piping, both had a direct relationship with the degradation, and the probability of strong degradation is 7.51% in the South and 6.16% in the Southeast.

5. Conclusion

With the purpose of studying the level of degradation in Brazil's countryside areas, the present work estimated an ordered logit model to verify the relationship between environmental degradation, economic growth and access to basic requirements. For this, data referring to the dimensions of environmental degradation, health, information and education of households interviewed by PNAD in 2015 were used.

In the analysis of the indicator of environmental degradation, it was evidenced that the Northeast, followed by the North and the Midwest, is the region in which the households are most inadequate regarding the preservation of the environment, in which basic services are lacking, such as garbage collection, sanitary sewage, fuel used in the stove, and household lighting. On the other hand, the South-Southeast axis presents the households with the best sustainable conditions, which shows the high disparity between the Brazilian regions.

By analyzing the relationship between environmental degradation and economic growth for the Brazilian countryside environment, it was concluded that economic growth presented the inverted N format in relation to the degradation for all regions, with income and dimensions of access to education, health and information were crucial to this achievement. This fact underscores the importance of economic growth and basic sanitation and health factors for sustainable development of countryside areas.

The results are extremely relevant as we can know the situation of countryside households in each Brazilian region and, from this, stimulate policies to combat environmental degradation, taking into account the aspects of regional policies and their heterogeneities. Therefore, it is understood that a way to try to reverse the degradation will only be possible with a firm purpose for public power action, associated with the effective involvement of society in the construction of solutions that emphasize the preservation of the Brazilian countryside environment.

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Appendixes

Appendix 1. Determinants of likelihood of Environmental Degradation in the countryside areas of the North and Northeast regions of Brazil

VARIABLE	North	MARGINAL EFFECTS				Noortheast	MARGINAL EFFECTS			
		No Degradation	Weak Degradation	Medium Degradation	Strong Degradation		No Degradation	Weak Degradation	Medium Degradation	Strong Degradation
Per capita income	$-0{,}0005^{***}$ (-11,46)	$5{,}77e^{-05}$ (11,44)	$5{,}26e^{-05}$ (11,26)	$-4{,}16e^{-05}$ (-11,28)	$-6{,}86e^{-05}$ (-11,36)	$-0{,}0011^{***}$ (-15,68)	$1{,}07e^{-04}$ (15,29)	$1{,}36e^{-04}$ (15,75)	$-6{,}73e^{-05}$ (-14,93)	$-1{,}76e^{-04}$ (-15,66)
Per capita income ^2	$6{,}72e^{-8\,***}$ (8,22)	$-6{,}51e^{-09}$ (-8,19)	$-5{,}94e^{-09}$ (-8,16)	$4{,}70e^{-09}$ (8,13)	$7{,}75e^{-09}$ (8,19)	$3{,}31e^{-7\,***}$ (7,24)	$-2{,}97e^{-8}$ (-7,19)	$-3{,}79e^{-8}$ (-7,26)	$1{,}87e^{-8}$ (7,14)	$4{,}89e^{-8}$ (7,25)
Per capita income ^3	$-1{,}51e^{-12\,***}$ (-6,73)	$1{,}46e^{-13}$ (6,71)	$1{,}34e^{-13}$ (6,70)	$-1{,}06e^{-13}$ (-6,67)	$-1{,}74e^{-13}$ (-6,72)	$-2{,}19e^{-11\,***}$ (-5,31)	$1{,}96e^{-12}$ (5,29)	$2{,}50e^{-12}$ (5,32)	$-1{,}23e^{-12}$ (-5,27)	$-3{,}23e^{-12}$ (-5,32)
Information through the radio	$-0{,}0194^{***}$ (-5,44)	0,0188 (5,43)	0,0171 (5,43)	-0,0135 (-5,41)	-0,0224 (-5,44)	$0{,}0214^{NS}$ (0,78)	-0,0019 (-0,78)	-0,0024 (-0,78)	0,0012 (0,78)	0,0031 (0,78)
Information through the TV	$1{,}4196^{***}$ (25,16)	-0,1377 (-22,62)	-0,1257 (-23,33)	0,0994 (18,34)	0,1639 (27,76)	$1{,}0064^{***}$ (16,74)	-0,0903 (-16,15)	-0,1151 (-16,66)	0,0568 (14,78)	0,1486 (17,03)
Information through the internet	$1{,}0394^{***}$ (19,59)	-0,1008 (-19,41)	-0,0919 (-19,09)	0,0728 (20,10)	0,1200 (18,63)	$0{,}6260^{***}$ (19,08)	-0,0561 (-18,54)	-0,0716 (-19,24)	0,0353 (18,49)	0,0924 (18,85)
Years of study	$-0{,}0455^{***}$ (-9,08)	0,0044 (9,03)	0,0040 (9,05)	-0,0031 (-9,01)	-0,0052 (-9,04)	$-0{,}0336^{***}$ (-9,47)	0,0030 (9,40)	0,0038 (9,48)	-0,0019 (-9,30)	-0,0049 (-9,46)
School attendance	$-0{,}0218^{NS}$ (-0,39)	0,0021 (0,39)	0,0019 (0,39)	-0,0015 (-0,39)	-0,0025 (-0,39)	$-0{,}0611^{NS}$ (-1,55)	0,0054 (1,55)	0,0069 (1,55)	-0,0034 (-1,55)	-0,0009 (-1,55)
Access to piped water	$1{,}3785^{***}$ (31,55)	-0,1556 (-26,98)	-0,0963 (-32,54)	0,1037 (25,70)	0,1487 (31,46)	$1{,}2204^{***}$ (43,34)	-0,1095 (-35,31)	-0,1396 (-45,59)	0,0689 (29,46)	0,1802 (45,08)
Access to filtered water	$-0{,}2733^{***}$ (-6,35)	0,0265 (6,33)	0,0241 (6,35)	-0,0191 (-6,33)	-0,0315 (-6,34)	$-0{,}0395^{NS}$ (-1,53)	-0,0035 (1,53)	-0,0045 (1,53)	-0,0022 (-1,53)	-0,0058 (-1,53)
Log likelihood	-12861,899					Log likelihood	-25759,841			
Pseudo R^2	0,1310					Pseudo R^2	0,0758			
Number of observations	11.721					Number of observations	21.643			

Source: Prepared by the authors from the estimated results.

Note 1: *** Significant at 1%, NS not significant at 10%.

Note 2: Z statistics in parentheses for N = 11,721 (in the case of the North), and N = 21,643 for the Northeast

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Appendix 2. Determinants of likelihood of Environmental Degradation in the countryside areas of the South and Southeast Regions of Brazil

VARIABLE	South	MARGINAL EFFECTS				Southeast	MARGINAL EFFECTS			
		No Degradation	Weak Degradation	Medium Degradation	Strong Degradation		No Degradation	Weak Degradation	Medium Degradation	Strong Degradation
Per capita income	$-0,0007^{***}$ (-6,66)	$1,64e^{-04}$ (6,71)	$-6,77^{-6}$ (-2,98)	$-9,24e^{-05}$ (-6,68)	$-6,47e^{-05}$ (-6,52)	$-0,0007^{***}$ (-11,93)	$1,28e^{-04}$ (12,22)	$2,62e^{-05}$ (9,66)	$-7,01e^{-05}$ (-11,87)	$-8,47e^{-05}$ (-11,58)
Per capita income ^2	$2,44e^{-7\ ***}$ (5,14)	$-5,34e^{-8}$ (-5,16)	$2,21e^{-9}$ (2,80)	$3,01e^{-8}$ (5,15)	$2,11e^{-8}$ (5,07)	$8,17e^{-8\ ***}$ (8,17)	$-1,47e^{-8}$ (-8,25)	$-2,99e^{-9}$ (-7,36)	$7,99e^{-9}$ (8,16)	$9,65e^{-9}$ (8,05)
Per capita income ^3	$-2,07e^{-11\ ***}$ (-4,40)	$4,52e^{-12}$ (4,42)	$-1,87e^{-13}$ (-2,67)	$-2,55e^{-12}$ (-4,40)	$-1,79e^{-12}$ (-4,36)	$-1,92e^{-12}$ *** (-6,66)	$3,45e^{-13}$ (6,71)	$7,04e^{-14}$ (6,21)	$-1,88e^{-13}$ (-6,66)	$-2,27e^{-13}$ (-6,60)
Information through the radio	$-0,0683^{***}$ (-9,44)	0,1495 (9,64)	-0,0061 (-3,21)	-0,0843 (-9,49)	-0,0590 (-9,02)	$-0,4328^{***}$ (-8,19)	0,0776 (8,24)	0,0158 (7,55)	-0,0423 (-8,18)	-0,0511 (-8,09)
Information through the tv	$0,7451^{***}$ (4,90)	-0,1631 (-4,91)	0,0067 (2,67)	0,0920 (4,91)	0,0643 (4,86)	$0,8416^{***}$ (6,51)	-0,1509 (-6,50)	-0,0308 (-6,34)	0,0823 (6,44)	0,0994 (6,53)
Information through the internet	$0,6048^{***}$ (11,93)	-0,1324 (-12,33)	0,0054 (3,26)	0,0746 (12,09)	0,0522 (11,08)	$1,1046^{***}$ (22,50)	-0,1980 (-24,30)	-0,0404 (-14,15)	0,1080 (23,11)	0,1304 (20,41)
Years of study	$-0,0212^{***}$ (-3,27)	0,0046 (3,28)	-0,0001 (-2,36)	-0,0021 (-3,27)	-0,0018 (-3,25)	$-0,0522^{***}$ (-8,48)	0,0093 (8,55)	0,0019 (7,68)	-0,0051 (-8,45)	-0,0061 (-8,38)
School attendance	$0,0203^{NS}$ (0,22)	-0,0044 (-0,22)	0,0001 (0,22)	0,0025 (0,22)	0,0017 (0,22)	$-0,3842^{***}$ (-5,16)	0,0689 (5,17)	0,0140 (5,01)	-0,0375 (-5,15)	-0,0453 (-5,14)
Access to piped water	$0,8698^{***}$ (5,67)	0,1904 (-5,68)	0,0078 (2,78)	0,1074 (5,68)	0,0751 (5,60)	$0,5219^{***}$ (6,23)	-0,0935 (-6,23)	-0,0191 (-6,07)	0,0510 (6,21)	0,0616 (6,21)
Access to filtered water	$0,2753^{***}$ (4,42)	-0,0602 (-4,44)	0,0024 (2,69)	0,0340 (4,43)	0,0237 (4,37)	$-0,3700^{***}$ (-8,10)	0,0663 (8,15)	0,0135 (7,49)	-0,0361 (-8,07)	-0,0437 (-8,03)
Log likelihood		-7935,2567				Log likelihood	-9316,8682			
Pseudo R^2		0,0315				Pseudo R^2	0,0632			
Number of observations		6.326				Number of observations	7.344			

Source: Prepared by the authors from the estimated results.

Note 1: *** Significant at 1%, NS Not significant at 10%.

Note 2: Z statistics in parentheses for N = 6,326 for the South region, and N = 7,344 for the Southeast region

Appendix 3. Determinants of likelihood of Environmental Degradation in the countryside areas of the Midwest Region of Brazil

VARIABLE	Midwest	MARGINAL EFFECTS			
		No Degradation	Weak Degradation	Medium Degradation	Strong Degradation
Per capita income	-0,0005*** (-3,07)	$6{,}79e^{-05}$ (3,06)	$6{,}39e^{-05}$ (3,07)	$-8{,}79e^{-05}$ (-3,07)	$-4{,}47e^{-05}$ (-3,04)
Per capita income ^2	$2{,}67e^{-7}$ *** (2,90)	$-3{,}13e^{-8}$ (-2,89)	$2{,}94e^{-8}$ (2,90)	$4{,}06e^{8}$ (2,90)	$2{,}01e^{-8}$ (2,87)
Per capita income ^3	$3{,}24e^{-11}$ *** (-3,08)	$3{,}80e^{-12}$ (3,07)	$3{,}56e^{-12}$ (3,07)	$-4{,}91e^{-12}$ (-3,08)	$-2{,}44e^{-12}$ (-3,05)
Information through the radio	0,0955NS (1,36)	-0,0112 (-1,36)	-0,0105 (-1,36)	0,0145 (1,36)	0,0072 (1,36)
Information through the TV	0,7607*** (5,36)	-0,0892 (-5,28)	-0,0836 (-5,39)	0,1154 (5,37)	0,0573 (5,23)
Information through the internet	0,9490*** (13,01)	-0,1113 (-12,46)	-0,1043 (-13,26)	0,1440 (13,90)	0,0715 (10,92)
Years of study	-0,0401*** (-4,57)	0,0047 (4,55)	0,0044 (4,57)	-0,0063 (-4,60)	-0,0030 (-4,46)
School attendance	-0,2342** (-2,16)	0,0274 (2,16)	0,0257 (2,16)	-0,0355 (-2,16)	-0,0176 (-2,15)
Access to piped water	0,8278*** (5,62)	-0,0971 (-5,55)	-0,0909 (-5,65)	0,1256 (5,65)	0,0624 (5,45)
Access to filtered water	0,3103*** (4,78)	-0,0364 (-4,74)	-0,0341 (-4,79)	0,0471 (4,81)	0,0234 (4,65)
Log likelihood		-4128,0349			
Pseudo R^2		0,0476			
Number of observations		3.559			

Source: Prepared by the authors from the estimated results.

Note 1: *** Significant at 1%, ** Significant at 5%, NS Not significant at 10%.

Note 2: Z statistics in parentheses for N = 3,559.